FGC Forest Genetics Council of British Columbia

Annual Report 2014/15

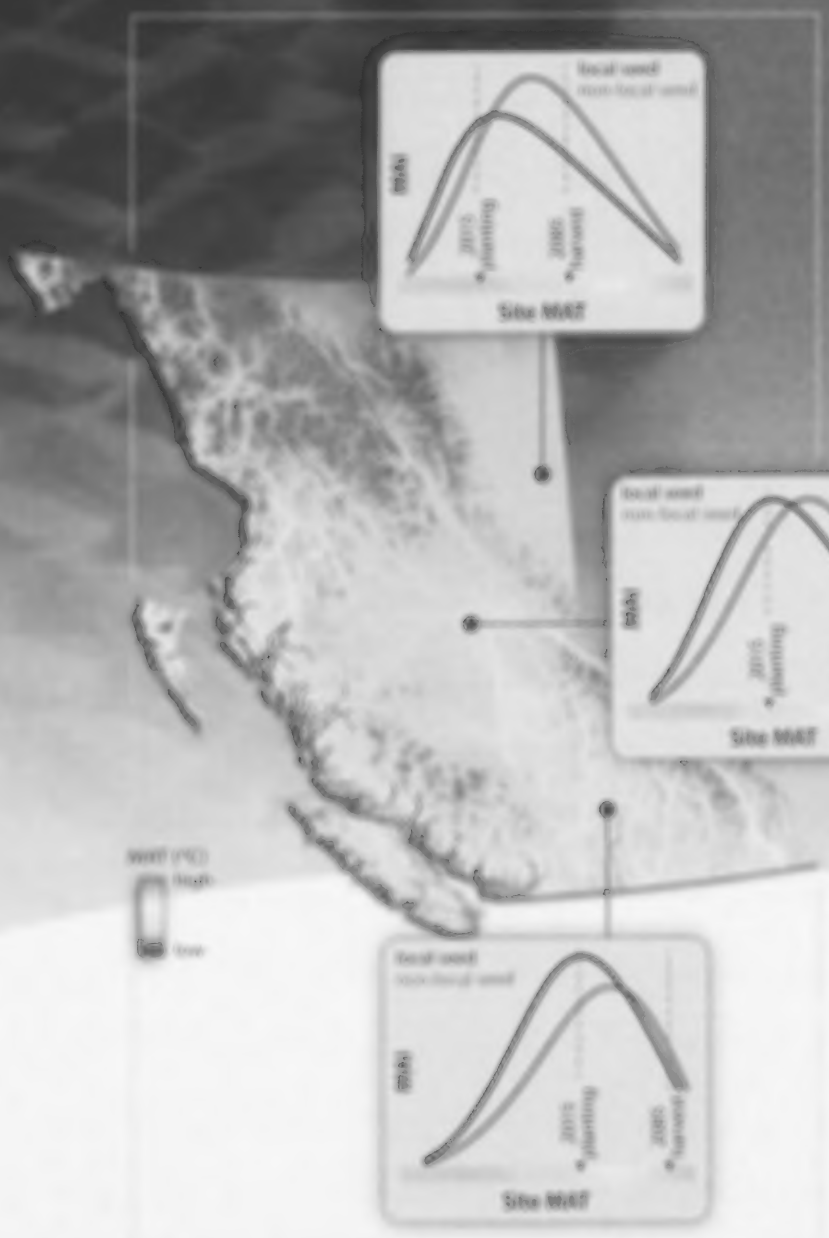


Table of Contents

1.0 Introduction 2
1.1 Tree improvement and forest genetic resource management in British Columbia 2
1.2 About the Forest Genetics Council of British Columbia 2
1.3 FGC vision and objectives 3

2.0 Budget and Expenditures 4

3.0 Performance Indicators 5
3.1 Increase seedlot genetic worth 5
3.2 Increase select seed use 6
Feature: Lodgepole pine challenges orchard managers to meet seed demands 8
3.3 Adequately conserve genetic diversity 9
3.4 Climate-based seed transfer 9
Feature: How big should orchards be to meet seed demand? 10
Feature: Lodgepole pine class A vs B seed; early growth and cold hardiness 11
3.5 Coordinate stakeholder activities 12
3.6 Monitor and report progress 13

4.0 2014 Orchard Seed Crops 14

Canadian Cataloguing in Publication Data

Forest Genetics Council of British Columbia

Annual report. -- 2000/2001

Annual.
Title from cover
Issuing body varies.
ISSN 1499-125X = Annual report - Forest Genetics Council of British Columbia

1. Forest Genetics Council of British Columbia - Periodicals.
2. Trees -
SD399.5.B74 634.9'8'09711'05 C2001-960195-6

Cover graphic: Lodgepole pine assisted migration

Image prepared by
C. Chourmouzis

Provenance trials test seed from different climatic areas in field trials located on operational forestry sites. These trials help us understand the impacts of climate change on forest growth and health, and identify seed sources expected to perform best in changing climates. This example from lodgepole pine provenance trials established in the 1970s, shows the growth rate of local and a best non-local (migrated) seed sources modeled with site temperature changes from the time of planting to the time of harvest (shown here for simplicity as mean annual temperature - MAT).

Productivity, measured as mean annual increment (MAI) in m^3 per hectare, increases slightly as climate warms in some locations, but declines toward the end of the rotation at all locations. This decline in MAI is partially or wholly mitigated by choosing seed sources from climatic areas best suited to expected future climates. Benefits from using the best non-local seed source are greater in cooler climatic areas, as existing local sources can be replaced with faster-growing sources from warmer areas (northern-most graph). In warmer and drier areas, increased warming may result in a loss of productivity over the next rotation regardless of seed source, suggesting that a shift to a species more suited to the warmer climate is warranted for these sites.

Provincial seed transfer policy will change incrementally and conservatively as new research and climate-modelling information comes available. These changes will minimize risk and mitigate (or enhance) productivity declines due to climate change.

Messages

We would like to congratulate the Forest Genetics Council of BC (FGC) for completing their 14th consecutive annual business plan and report. The FGC's program continues to be one of the core elements of the Land Base Investment Strategy. These investments, combined with those from the forest sector, account for over 50% of the ministry's annual service plan performance measure for timber-supply gains attributed to incremental silviculture investments.

The FGC remains an effective forum for soliciting stakeholder input and developing policies and priorities. We are pleased the FGC continues to deliver a well-balanced program that considers the economic gains from breeding and seed orchard programs, improves forest health and resilience, and maintains genetic diversity to enhance our future forests. We note in this report long-term progress across a broad spectrum of activities from select seed use to genetic conservation.

We would like to thank members of the FGC, and its affiliated technical committees, for their contributions and enthusiasm.

DIANE NICHOLLS
A / Chief Forester
and Executive Director,
Resources Stewardship
Division

and

TOM ETHIER
Assistant Deputy Minister
Resource Stewardship

BC Ministry of Forests
Lands and Natural
Resource Operations

During the term of this report, the FGC developed a new Strategic Plan for the period 2015 to 2020. This plan sets out a challenging and balanced set of objectives for the cooperative provincial forest genetics program. Looking back at the many successes of this program and looking forward to the completion of many projects currently underway, we are confident that Council's vision can be realized.

During the past year Council met quarterly, including a field trip to Western Forest Products Ltd's. Saanich Forestry Centre, which was celebrating its 50th anniversary. This seed orchard and nursery complex demonstrates the success of FGC and its predecessors, and the commitment of our private sector partners.

We would like to thank Larry Gardner for his service on Council as an Interior Industry representative and as Industry Co-Chair from 2010 to 2015. We would also like to extend our gratitude to the many people in government, industry and universities who added to this cooperative program.

BRIAN BARBER
Co-Chair,
Forest Genetics
Council of BC

Director,
Tree Improvement
Branch, FLNRO

MARK TAMAS
Co-Chair,
Forest Genetics
Council of BC

Chief Forester,
Tolko Industries
Ltd.

I'm proud to present the 2014/15 FGC Annual Report; the 14th consecutive report in a series that provides a solid record of achievement and action by many people. Further details are available in the FGC Business Plan for 2014/15, and the Tree Improvement Program Projects Report for 2014/15. I would like to thank members of the FGC and Council's technical advisory committees, as well as the many others who contribute to the success of this program.

During the 2015 sowing year, seeds for 263 million seedlings were sown in BC. Of these, 158 million came from Class A seed sources, adding very substantially to the province's long-term timber supply potential. Provincial breeding programs continue to advance the process of genetic selection, and seed orchards are well positioned to meet provincial demands for Class A seed.

JACK WOODS,
Program Manager,
Forest Genetics
Council of BC

The FGC Annual Report presents provincial-level performance indicators for genetic resource management.

1.0 Introduction

This Annual Report presents provincial-level performance indicators outlined in the FGC Strategic Plan for 2009 to 2014. It also summarizes outcomes from projects funded through the Land Based Investment Strategy (LBIS) Tree Improvement Program. These projects are outlined in the Forest Genetics Council of BC (FGC) Business Plan for 2014/15. Performance indicators reported here represent results from both LBIS investments and the investment of cooperators.

1.1 Tree improvement and forest genetic resource management in British Columbia

Tree improvement and forest genetic resource management (GRM) includes increasing value through tree breeding and seed production, conserving the genetic diversity of indigenous forest tree species, and enhancing forest resilience through scientifically-based seed transfer standards and forest health. Support activities including research, extension, and records management also advance provincial GRM initiatives.

1.2 About the Forest Genetics Council of British Columbia

The FGC represents stakeholders in the management and conservation of the genetic resource of indigenous tree species.

The FGC is a multi-stakeholder group representing government agencies (Ministry of Forests Lands and Natural Resource Operations - FLNRO), the forest industry, universities, the Canadian Forest Service, and smaller forest-sector companies. The mandate of the FGC is to champion forest GRM, to oversee strategic and business planning for a cooperative provincial GRM program, and to advise the provincial Chief Forester and the Assistant Deputy Minister, Resource Stewardship, on GRM policies.

The FGC leads program development and business planning for provincial investments through the LBIS, and seeks efficiencies for all investments, including those by industry and university cooperators.

1.3 FGC vision and objectives

Council set the following vision statement and objectives in its five-year Strategic Plan (2009-2014), and annually develops a Business Plan outlining activities to meet these objectives.[1] Council is developing new objectives in a Strategic plan for the period 2015 to 2020.

Vision

BC's forest genetic resources are diverse, resilient, and managed to provide multiple values for the benefit of present and future generations.

Objectives

- *Increase the average volume gain of select seed used for Crown land reforestation to 20% by the year 2020*
- *Increase select seed use to 75% of the provincial total sown by 2014*
- *Adequately conserve the genetic diversity of key populations of all forest tree species native to BC by 2015, through a combination of in situ, ex situ, and inter situ conservation*
- *By 2020, high-quality genecology research information will guide operationally efficient climate-based seed transfer policy and practice for all trees planted in BC*
- *Coordinate stakeholder activities and secure the resources needed to meet Business Plan priorities*
- *Monitor and report progress in genetic resource management activities*

Retirements

Diane Douglas
Diane began her public service career with the Ministry of Agriculture in 1992 and later transferred to the FLNRO Tree Improvement Branch. Diane chaired the Extension Technical Advisory Committee from 2008 to 2015.

Karen Turner
Seed Orchard Technician with the FLNRO at Skimikin Seed Orchards from 1992 to 2014.

[1] For more information on the Forest Genetics Council, see *http://www.fgcouncil.ca*.

2.0 Budget and Expenditures

Land Based Investment Strategy Tree Improvement Program and SelectSeed Ltd. allocations and expenditures for the 2014/15 fiscal year that were made in support of the provincial GRM program are shown in Table 1. The table excludes in-kind costs, staff salaries, and other substantial inputs by industry, FLNRO, and university cooperators that contribute to the success of GRM activities in BC.

Table 1
Summary of Land Based Investment Strategy Tree Improvement Program budgets and expenditures for the period April 1, 2014 through March 31, 2015 ($ x 1000).

LBIS Tree Improvement Program	Budget ($)	Expenditures ($)
Genetic Conservation	222	222
Tree Breeding	1,123	1,280
Operational Tree Improvement Program (OTIP)	512	419
Extension and Communication	12	12
Cone and Seed Pest Management	81	78
Genecology and Seed Transfer	265	260
Genetic Resource Decision Support	115	56
Applied Tree Improvement and Biotechnology	159	159
Administration	10	11
Total	**2,500**	**2,497**
SelectSeed Ltd. expenditures on behalf of FGC*	152	140

*SelectSeed provided program management services and paid expenses for communications (website, publications), meetings, research, and consulting on behalf of the FGC.

Non-allocated funds remained with FLNRO and were either re-allocated within the LBIS program or returned to provincial general revenue. Noteworthy is the support of FGC activities by Council-owed SelectSeed Ltd. These funds were derived from revenues on the sale of seed produced in orchards operated under contract to SelectSeed Ltd.

Under-spending in the Operational Tree Improvement Program is due to orchard crops being generally lower than anticipated in 2014, requiring less crop and pest management work than anticipated. The primary reallocation of funding was from OTIP to Tree Breeding to meet ongoing needs for progeny testing and assessments.

3.0 Performance Indicators

Progress towards objectives set out in the FGC's new Strategic Plan for the period 2009-2014 (see section 1.3) are measured and reported annually. Two of these objectives are to increase the average genetic worth (GWg[1]) of Class A select seed to 20% by 2020 and to increase select seed[2] use to 75% by 2014 (this objective has been moved to 2020 in the new FGC Strategic Plan for 2015-2038). Province-wide performance on these objectives is shown below.

3.1 Increase seedlot genetic worth

Performance measure

Increase the average volume gain of select seed used for Crown land reforestation to 20% by the year 2020.

Performance

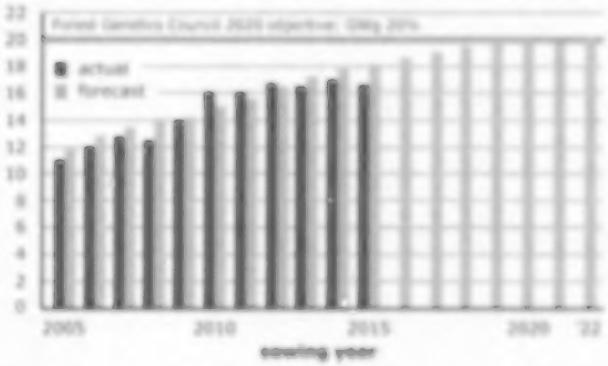


Figure 1
Actual and forecast annual average genetic worth for stem-volume growth (GWg) of select seed sown in BC.

The average GWg of select seed sown in the 2015 sowing year dropped to 16.6% from 17.0% the previous year, below a forecast of 18.1% (Figure 1). This decline is primarily due to a poor 2014 orchard-seed production year for lodgepole pine that resulted in less sowing and a lower average GWg than the previous year. Redcedar sowing of high-gain seed also dropped slightly. On the positive side, sowing of GWg seed for interior Douglas-fir and western larch increased. Gains from the use of interior Douglas-fir are expected to continue as orchards enter full production.

[1] Genetic worth is a measure of rotation-age gain in a specific trait, relative to non-selected wild seed. Genetic worth for growth (GWg) is a measure of stand-based gains in wood volume expressed as a percentage.

[2] Select seed includes Class A seed from seed orchards and Class B+ seed from natural stands that have been identified for superior growth performance in field-based provenance trials.

3.2 Increase select seed use

Objective

Increase select seed use to 75% of the provincial total sown by 2014.

Performance

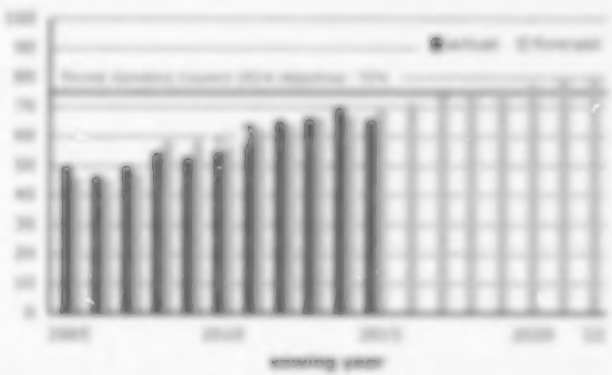


Figure 2
Actual and species-plan forecasts of select seed use as a percentage of total provincial seed use, by year.

Select seed use as a percentage of total provincial sowing dropped to 66.0% in the 2013 sowing year from 70.2% the previous year (Figure 2). This decrease is below the forecast level of 71.7%. Total provincial sowing decreased slightly to 265 million seedlings from 268 the previous year. Overall sowing of Class A seed totaled 138 million, down from 163 million in 2014, but still the second highest level achieved (Figure 3). The objective of 75% select seed use by 2014 was not met, but substantial progress was made over the previous 5 years.

The 2013 sowing year was the fourth consecutive year with provincial sowing levels above 250 million. High demand for select seed as challenging provincial orchards to meet seed needs for some seed planning units (SPU). In particular, lodgepole pine orchards for northern areas continue to produce at levels below expectations. This problem will be partially alleviated by new lodgepole pine orchards at Skeetchestn and Quesnel entering the production phase.

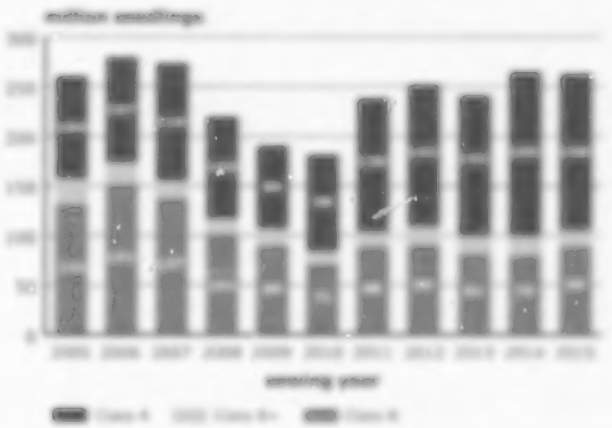


Figure 3
Provincial sowing of orchard (Class A), wild-stand (Class B), and superior provenance seed (Class A+) from 2005 to 2015.

[illegible] on lodgepole pine on-hand management also drive some [illegible] for increasing seed production (see Feature article below).

Class A seed use for western larch, coastal Douglas-fir, western redcedar (coast), western white pine, Sitka spruce, and western hemlock remains high due to generally adequate on-hand seed supplies. On-hand seed use for interior Douglas-fir continues to rise as on-hand stocks, while interior spruce once again accounts for over 30% of provincial class A sowing (Figure 4).

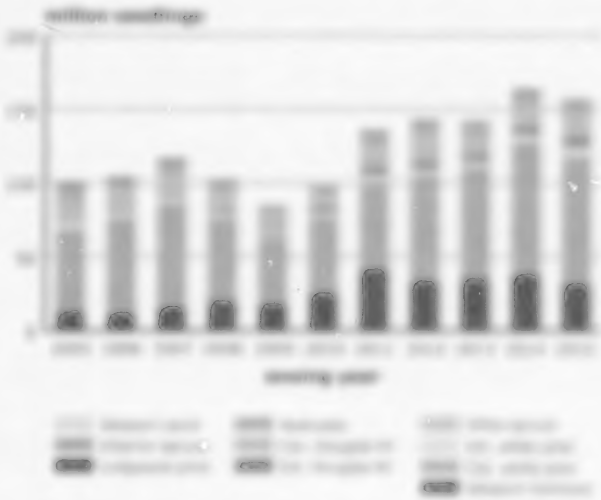
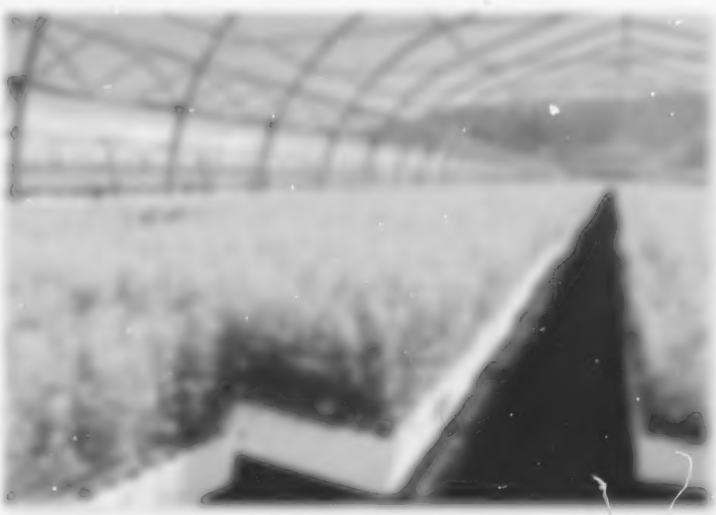


Figure 4
Provincial sowing of orchard seed (Class A) by species from 2009 to 2019.



Class A interior Douglas-fir seedlings being grown by Mamaks Nurseries Ltd. for the Nelson tree selection seed zone. In 2019, about half of the 4 million seedlings produced for this zone were from class A seed. This proportion is increasing.

(photo: C. Kozak)

[illegible]

Lodigepole pine challenges orchard managers to meet seed demands

Lodigepole pine (PL) is the dominant species planted in BC, accounting for 38% to 52% of annual provincial planting over the past decade. Despite a shift to planting other species and species mixes, PL remains a preferred species for large parts of the BC interior.

PL presents several seed production challenges that translate to higher costs and higher risks for seed orchard managers. These challenges include difficult grafting, lower cone production, and fewer seeds per cone compared to other species. Cone harvest is laborious because cones are dispersed throughout the crown, and the cones' sticky, resinous nature makes them difficult to process. PL seedlings, prepared in standard containers, are also more susceptible to winter injury or "frost and drought" each year. In addition, PL seeds usually more than 20 viable filled seeds per cone (VFSPC), and it is VFSPC that is the key factor in determining seed orchard yield. For comparison, spruce orchards average 40 to 50 filled seeds per newly picked cone.

PL's low number of cones per tree and low VFSPC require the establishment of large orchards to meet seed demand. Presently, 21% of the 117 thousand grafted trees in BC's orchards are PL. However, these PL grafts are producing less than half the seed needed for this species. New orchards established at Skimikin by the TimberWest and by Vernon Seed Orchard Company and Quesnel will help increase supply. Changes in future harvest levels and reforestation trends, and the implementation of climate-based seed transfer, could reduce or increase the demand for PL orchard seed.

Increasing the number of cones per tree and VFSPC has been the focus of research supported through the FSP. This work includes using plant growth regulating hormones such as gibberellins and ave GA to stimulate increased flowering. Although ave GA4/7 does not affect cone development, single sweet trials of gibberellin and ave increased cone production by about 20%. These can only be treated every 2 or 3 years, however, so overall orchard production increases will be lower (10%). Refined hormone treatment methods are expected to improve cone and seed production in the future.

A subject of much research over the past 10 years is the relatively small number of viable or filled seeds per cone (VFSPC). This is a very challenging area of investigation due to many causes, with each cause playing on a different scale of importance in different seed years. Research has suggested that self-pollination reduces VFSPC as there is a natural genetic barrier preventing inbred from developing. Other research has shown that seed predation by the western conifer seed bug (Leptoglossus occidentalis) also has a large impact on VFSPC some years. In younger orchards, 20 to 25 years

Top: Bird damage of a USDA cone PL cones in the Kalamalka seed orchard. Left: Lodgepole pine "flower" (megasporangiate strobili) at the tips of conifer branches. Right: A developing cone of a PL tree in Kalamalka seed orchard showing many deep dark cones and thick, dark shield (scale) to sporophore (reference), self-pollinated, or an unknown cause (photos: C. Wallis).

other cool weather or differentiation to pollinators, insufficient pollen reaching the emerging "flowers" can be a problem. Other potential causes such as high temperatures, drought, and irrigation have also been investigated. No research to date indicates that these factors do not significantly influence VFSPC. Low VFSPC appears to be caused by a combination of sporophytic problems, poor pollination, self-pollination, and currently unknown factors.

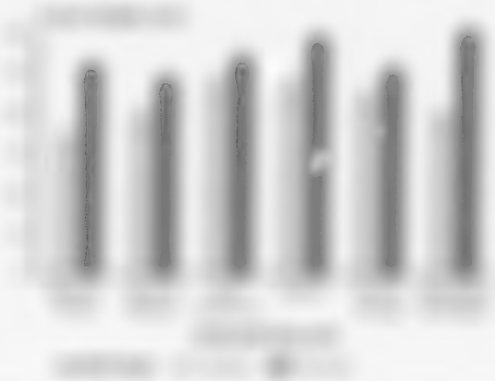
Meeting PSE objectives for select seed use and genetic gain requires higher production from PL orchards. Orchard operators and researchers continue to work together to meet this challenge.

[illegible]

[illegible]

[illegible] [illegible] [illegible] [

[illegible]



3.5 Coordinate stakeholder activities

Objectives

Coordinate stakeholder activities and secure the resources needed to meet Business Plan priorities.

Performance

During the period of this report, the FGC had completion of:

- an activity plan and associated budget recommendations for the Land Based Investment Strategy Tree Improvement Program for 2015/16;
- a published Business Plan and full set of species plans for 2015/16;
- a published FGC Annual Report and Progress Report for 2013/14;
- ongoing management of committee work and collaboration on issues;
- development of a Strategic Plan for 2015-2020, including community of practice and stakeholder surveys seeking input on priorities.

Council met four times during the fiscal year, including a meeting at Western Forest Products Ltd. wood orchard and nursery facilities in Saanichton, BC. During the year, Industry Co-Chair Larry Gardiner of West Fraser Timber resigned from Council due to a change of employment responsibilities. Mark Tamas, Teal-Jones Ltd. was appointed as Industry Co-Chair. A milestone agreement was also reached between the FLNRO and Teal-Jones Ltd., in which Teal-Jones will provide support for a one-person tree breeder position within the Tree Improvement Branch for three years. Other business, including the development of a full suite of activities and accompanying budgets was developed to guide FLNRO spending under the LBIS Tree Improvement Program.

Douglas-fir cones in an orchard operated by PRT Growing Services in partnership with Teal-Jones Ltd. and producing for the Nelson box elevation seed zone.

(Photo: I. Mosseler)

3.6 Monitor and report progress

Objective

Monitor and report progress in genetic resource management activities.

Performance

This objective was met through the development and publication of a comprehensive Business Plan for 2014/15, including species plans that outline breeding programs, seed orchards, historic seed use and production, and other data relevant to an efficient multi-stakeholder provincial program. Performance indicators for objectives set out in the FGC Strategic Plan are reported in this document. Project level reporting is summarized in the Tree Improvement Project Report for 2014/15.

Site and owner	Number of seed orchards	Total #of ramets established	Ramets under contract with Interfor and Ltd.
Vernon Seed orchard Company Ltd.	17	30,782	8,335
Kalamalka Seed orchards (FLNRO)	17	18,835	
Skimikin Seed Orchards (FLNRO)	15	18,805	
PRT Growing Services Ltd.	6	11,897	9,905
Kettle River Seed Orchards	2	7,730	7,730
TimberWest Forests Ltd.	7	5,757	
Tolko Ltd.	4	5,910	4,980
Sorrento Nurseries Ltd.	2	5,065	5,065
Western Forest Products Inc.	12	3,958	
Saanich Seed Orchards (FLNRO)	4	3,582	
Prince George Tree Improvement Stn. (FLNRO)	3	3,198	
Small private (2 sites)	6	1,966	
Canadian Forest Products Ltd.	1	700	
Total	95	117,275	35,915

Table 2
Seed orchards in BC, summarized by site.

Douglas-fir pollen buds ready to shed their pollen. Pollen management in seed orchards is one of the keys to obtaining good seed production.

(photo J. Woods)

[1] Excludes yellow cypress hedge orchards for rooted cutting production owned by Western Forest Products Inc. and the FLNRO Cowichan Lake Research Station.

4.0 2014 Orchard Seed Crops

Cone and seed crops were again low for most species in 2014, with the exceptions of redcedar and western larch (Table 3; Figure 5). This was the fourth consecutive year with poor interior spruce crops. Lodgepole pine seed production was down, at least partly due to high levels of western conifer seed bug. A trial testing the pesticide Matador substantially increased the number of viable seeds per cone, offering hope for a management tool that can increase lodgepole pine seed production.

The total 2014 harvest of 872 kilograms of seed is sufficient to grow approximately 75 million seedlings.

Table 3
Summary of 2014 seed crops from provincial orchards.

Species	Seed produced (kg)	Seedling equivalents (million)
Interior spruce	142	16.7
Lodgepole pine	109	12.3
Western larch	276	20.8
Interior Douglas-fir	65	2.1
White pine	15	0.3
Western redcedar	45	12.5
Sitka spruce	2.4	0.4
Coastal Douglas-fir	207	8.0
Western hemlock	10	1.4
Ponderosa pine	0.4	0.02
Total	872	74.5

Figure 5
Orchard seed production by species and year.